

Package: mvGoF (via r-universe)

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Title Assessing a multivariate goodness of fit

Version 0.0.0.9000

Description Functions for the computation of several goodness of fit statistics. Currently implemented are multivariate versions of well known EDF statistics: The Anderson-Darling and Cramer-von Mises statistics for multivariate uniformly(0,1) distributed data and the bivariate Kolmogorov- Smirnov statistic for (0,1) distributed data. Further Rosenblatt's transformation for multivariate normally distributed data is implemented, such that these tests can be applied as a test for normality.

Depends R (>= 3.3.0)

Imports copula, doParallel, foreach, MASS

Suggests gumbel

License GPL-3

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AD.cval *Compute critical value for the Anderson-Darling test*

Description

KS.cval returns the critical values of for the Anderson-Darling test statistic.

Usage

```
AD.cval(n, prob)
```

Arguments

n	Sample size.
prob	Quantile.

AD.quantiles *Quantiles of the Anderson-Darling test*

Description

KS.quantiles returns quantiles for the Anderson-Darling test.

Usage

```
AD.quantiles(
  alphas = c(0.25, 0.2, 0.15, 0.1, 0.05, 0.025, 0.01, 0.005, 0.0025, 0.001)
)
```

Arguments

alphas	Alpha levels for which the quantiles should be returned.
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See Also

[rtrafo](#) for Rosenblatt's transformation on elliptical and Archimedean copulas.

Examples

```
x <- matrix(rnorm(50), nrow=25, ncol=2)
```

AD.stat

Multivariate Anderson-Darling test statistic

Description

AD.stat returns the multivariate Anderson-Darling test statistic for uniformly distributed data.

Usage

```
AD.stat(x, nsum = 1000)
```

Arguments

x	The sample.
nsum	See <code>copula::polylog</code> .

Details

AD.stat uses `polylog` from the `copula` package.

See Also

Other "test statistics": [CvM.stat\(\)](#), [KSa.stat\(\)](#), [biKS.stat\(\)](#)

Examples

```
set.seed(102015)
u <- matrix(runif(50), ncol=2)
plot(u)
AD.stat(u)
#[1] 1.570951

x <- matrix( seq(0.01, 0.99, length=100), ncol=2)
plot(x)
AD.stat(x)

x <- matrix(c(0.5,0.1), ncol=2)
plot(x)
AD.stat(x)

x <- MASS::mvrnorm(n = 200, rep(0, 2), diag(1,2,2))
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)
AD.stat(u)
```

```

# true situation: Data from Gumbel copula with known corellation.
# false assumption: Gauss copula
# Rosenblatt#s transformation under wrong assumptions and computation of AD.stat
set.seed(5)
library("gumbel")
gdata <- qlnorm(rgumbel(50,alpha=2,dim=5))
pairs(gdata)
sigma2 <- matrix((1/sqrt(2)),nrow=5,ncol=5)-diag(((1/sqrt(2))-1),5)
sigma2
ndata <- qnorm(plnorm(gdata))
pairs(ndata)
rbdata <- rosenblatt.norm(ndata, rep(0,5),sigma2)
pairs(rbdata)
AD.stat(rbdata)

```

biKS.stat

Kolmogorov-Smirnov test statistic

Description

CvM.stat returns the value of the bivariate Kolmogorov-Smirnov test statistic

Usage

```
biKS.stat(u)
```

Arguments

u Data set. Coloumn size equals the dimension of the samples and the line number equals the number of observations.

Details

The Kolmogorov-Smirnov test statistic is in fact the same as the squared L_∞ star discrepancy.

See Also

- Justel, A, D. Pe~na and R. Zamar, 1997. A multivariate Kolmogorov-Smirnov test of goodness of fit. *Statistics & Probability Letters* 35, 251-259.
- Chiu, S.N. and K.I. Liu. Generalized Cramér-von Mises goodness-of-fit tests for multivariate distributions. *Computational Statistics & Data Analysis*, 53(11):3817-3834, 2009.

Other "test statistics": [AD.stat\(\)](#), [CvM.stat\(\)](#), [KSa.stat\(\)](#)

Examples

```

set.seed(102015)
u <- matrix(runif(50), ncol=2)
plot(u)
CvM.stat(u)
#[1] 0.006029274
biKS.stat(u)
#[1] 0.252292

x <- MASS::mvrnorm(n = 200, rep(0, 2), diag(1,2,2))
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)
CvM.stat(u)
#[1] 0.002172406
biKS.stat(u)
#[1] 0.1058533

u <- 1/array(9:4, c(6,2))
CvM.stat(u)
biKS.stat(u)

```

CvM.cval

Compute critical value for the Cramér-von Mises test

Description

KS.cval returns the critical values of for the Cramér-von Mises test statistic.

Usage

```
CvM.cval(n, prob)
```

Arguments

n	Sample size.
prob	Quantile.

CvM.quantiles

Quantiles of the Cramér-von Mises test

Description

KS.quantiles returns quantiles for the Cramér-von Mises test.

Usage

```
CvM.quantiles(
  alphas = c(0.25, 0.2, 0.15, 0.1, 0.05, 0.025, 0.01, 0.005, 0.0025, 0.001)
)
```

Arguments

alphas Alpha levels for which the quantiles should be returned.

See Also

[rtrafo](#) for Rosenblatt's transformation on elliptical and Archimedean copulas.

Examples

```
x <- matrix(rnorm(50), nrow=25, ncol=2)
```

CvM.stat

Multivariate Cramér-von Mises statistic

Description

CvM.stat returns the value of the Cramér-von Mises test statistic for testing uniformity.

Usage

```
CvM.stat(u)
```

Arguments

u Data set. Coloumn size equals the dimension of the samples and the line number equals the number of observations.

Details

The CvM test statistic is in fact the same as the squared L2 star discrepancy from *Warnock (1972)*. u has couloumn size equalto the dimension of the samples and line number equal to the number of observations.

See Also

- Warnock, T.T., 1972. Computational investigations of low discrepancy point sets. In: Zaremba, S.K. (Ed.), Applications of Number Theory to Numerical Analysis. Academic Press, pp. 319-343.
- Chiu, S.N. and K.I. Liu. Generalized Cramér-von Mises goodness-of-fit tests for multivariate distributions. Computational Statistics & Data Analysis, 53(11):3817-3834, 2009.

Other "test statistics": [AD.stat\(\)](#), [KSa.stat\(\)](#), [biKS.stat\(\)](#)

Examples

```
set.seed(102015)
u <- matrix(runif(50), ncol=2)
plot(u)
CvM.stat(u)
#[1] 0.1061887

x <- MASS::mvrnorm(n = 200, rep(0, 2), diag(1,2,2))
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)
CvM.stat(u)

u <- 1/array(9:4, c(6,2))
CvM.stat(u)
```

KS.cval*Compute critical value for the Kolmogorov–Smirnov test*

Description

KS.cval returns the critical values of for the Kolmogorov–Smirnov test statistic.

Usage

```
KS.cval(n, prob)
```

Arguments

n	Sample size.
prob	Quantile.

KS.quantiles*Quantiles of the Kolmogorov–Smirnov test*

Description

KS.quantiles returns quantiles for the Kolmogorov–Smirnov test.

Usage

```
KS.quantiles(
  alphas = c(0.25, 0.2, 0.15, 0.1, 0.05, 0.025, 0.01, 0.005, 0.0025, 0.001)
)
```

Arguments

alphas Alpha levels for which the quantiles should be returned.

See Also

[rtrafo](#) for Rosenblatt's transformation on elliptical and Archimedean copulas.

Examples

```
x <- matrix(rnorm(50), nrow=25, ncol=2)
```

KSa.stat	<i>approximative Kolmogorov-Smirnov test statistic</i>
----------	--

Description

KSa.stat returns the value of the approximative Kolmogorov-Smirnov test statistic

Usage

```
KSa.stat(u)
```

Arguments

u Data set. Coloumn size equals the dimension of the samples and the line number equals the number of observations.

Details

The statistic used by this function D_n^* from Justel, A.; Peña, D.; Zamar, R. (1997). "A multivariate Kolmogorov–Smirnov test of goodness of fit". *Statistics & Probability Letters* 35 (3): 251–259. doi:10.1016/S0167-7152(97)00020-5. as an approximation of the Kolmogorov-Smirnov test statistic.

See Also

- Justel, A, D. Pe~na and R. Zamar, 1997. A multivariate Kolmogorov-Smirnov test of goodness of fit. *Statistics & Probability Letters* 35, 251-259.
- Chiu, S.N. and K.I. Liu. Generalized Cramér–von Mises goodness-of-fit tests for multivariate distributions. *Computational Statistics & Data Analysis*, 53(11):3817-3834, 2009.

Other "test statistics": [AD.stat\(\)](#), [CvM.stat\(\)](#), [biKS.stat\(\)](#)

Examples

```

set.seed(102015)
u <- matrix(runif(50), ncol=2)
plot(u)
CvM.stat(u)
#[1] 0.006029274
KSa.stat(u)
#[1] 0.252292

x <- MASS::mvrnorm(n = 200, rep(0, 2), diag(1,2,2))
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)
CvM.stat(u)
#[1] 0.002172406
biKS.stat(u)
#[1] 0.1058533

u <- 1/array(9:4, c(6,2))
CvM.stat(u)
KSa.stat(u)

```

mvGoF

mvGoF: A package for computing several multivariate EDF goodness of fit statistics.

Description

Multivariate versions of the popular EDF statistics by *Cramér-von Mises*, *Anderson-Darling* and *Kolmogorov-Smirnov* are supported.

List of public functions

- [AD.stat](#): Anderson-Darling
- [CvM.stat](#): Cramér-von Mises
- [biKS.stat](#): bivariate Kolmogorov-Smirnov
- [rosenblatt.norm](#) Rosenblatt's transformation for normally distributed data

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Examples

```

# Evaluate percentiles of the distribution by Monte-Carlo simulation
# sampling from independent uniforms 0-1 for F_0 specified completely by H_0
n <- 10 # e.g. sample size 10
set.seed(14072016)

```

```

sims <- stat.MC(n,100,biKS.stat) # 100 MC simulations (usually larger)
# now quantiles can be estimated
quantile(sims)
# critical value for sample size 48 and alpha=0.05
KS.cval(48,0.05)

# for the Lilliefors statistic:
n <- 10 # e.g. sample size 10
set.seed(14072016)
sims <- stat.MC(n,100,biKS.stat) # 100 MC simulations (usually larger)

#evaluate empirical power of statistics
#set parameters of true distribution
(mu0 <- rep(0,2))
(Sigma0 <- diag(0.5,2,2)+matrix(0.5,2,2))
#set parameters for alternative distribution
nMC <- 1000 # number of MC simulations
n <- 15 # sample size
eps <- 0.4 #c(0.1,0.2,0.4)
mu <- c(3,3) #mu <- c(3,-1)
tmp.KS.n15.sims <- rep(NA, nMC)
tmp.AD.n15.sims <- rep(NA, nMC)
tmp.CvM.n15.sims <- rep(NA, nMC)
set.seed(15072016)
for (i in 1:nMC) {
  rbts <- rosenblatt.norm( ((1-eps)*MASS::mvrnorm(n, mu0, Sigma0) + eps*MASS::mvrnorm(n, mu, Sigma0)) ,mu0,Sigma0)
  tmp.KS.n15.sims[i] <- biKS.stat( rbts )
  tmp.AD.n15.sims[i] <- AD.stat( rbts )
  tmp.CvM.n15.sims[i] <- CvM.stat( rbts )
}
#length(t1.KS.n15.sims[t1.KS.n15.sims>KS.cval(15,0.05)])/length(t1.KS.n15.sims)
#length(t2.KS.n15.sims[t2.KS.n15.sims>KS.cval(15,0.05)])/length(t2.KS.n15.sims)
#length(t3.KS.n15.sims[t3.KS.n15.sims>KS.cval(15,0.05)])/length(t3.KS.n15.sims)
#t1: mu <- c(3,3), eps <- 0.1
#t2: mu <- c(3,3), eps <- 0.2
#t3: mu <- c(3,3), eps <- 0.4

```

rosenblatt.norm

Rosenblatt's transformation for normally distributed data

Description

rosenblatt.norm returns Rosenblatt's transformation of normally distributed vectors which are the lines of the array x, with mean vector Mu and correlation matrix Sigma.

Usage

```
rosenblatt.norm(x, Mu, Sigma)
```

Arguments

x	Array containing the data which have to be transformed. Each line represents a data vector with the coloumn number as dimension.
Mu	Mean vector.
Sigma	Correlation matrix.

See Also

[rtrafo](#) for Rosenblatt's transformation on elliptical and Archimedean copulas.

Examples

```
x <- matrix(rnorm(50), nrow=25, ncol=2)
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)

x <- MASS::mvrnorm(n = 500, rep(0, 2), diag(1,2,2))
plot(x)
u <- rosenblatt.norm(x, rep(0,2), diag(1,2,2))
plot(u)

# this example requires the gumbel package:
if (requireNamespace("gumbel", quietly = TRUE)) {
  set.seed(5)

  library("gumbel")
  gdata <- qlnorm(rgumbel(12,alpha=2,dim=5))
  pairs(gdata)

  sigma2 <- matrix((1/sqrt(2)),nrow=5,ncol=5)-diag(((1/sqrt(2))-1),5)
  sigma2

  ndata <- qnorm(plnorm(gdata))
  pairs(ndata)

  rbdata <- rosenblatt.norm(ndata, rep(0,5),sigma2)
  pairs(rbdata)

  AD.stat(rbdata)
}
```

Description

stat.MC returns the simulated values of function func.

Usage

```
stat.MC(n, rp, func)
```

Arguments

n	Sample size.
rp	Number of Monte Carlo simulations.
func	Function which evaluates the test statistic.

Examples

```
KS.n12test.sims <- stat.MC(12,100,biKS.stat)
# now quantiles can be estimated
quantile(KS.n12test.sims,probs=(1-c(0.01,0.05,0.1,0.25)))
```

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